Understanding Technology Acceptance: Phase 3 (Part 1) – Quantitative Modeling

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Executive Summary

The general research objectives of Phase III of the Technology Acceptance Project were two-fold: (1) use the quantitative model to predict technology acceptance; and (2) empirically assess communication methods for conveying product information that will increase acceptance by different customer segments. This report presents the results of the first objective and the results of the second objective are presented in Rogers, Fisk, Caine, Kwasny, Wilkison, Mayer, and Van Ittersum (2007).

We surveyed a sample of 5005 US corn growers with 500+ acres of corn regarding their willingness to accept Swath Control Technology for Planters. We received 579 responses, for a response rate of 11.8%. We find that the self-reported acceptance rate of the Swath Control Technology for Planters is 60%; that is, according to the self-reported behavioral measures, **sixty percent of the target market plans to buy Swath Control Technology for Planters**.

To gain an understanding of the determinants of the acceptance of the Swath Control Technology, we next tested our technology acceptance model. We find that the *behavioral acceptance* of Swath Control Technology for Planters is driven by the *intentional acceptance*, which in turn is driven by the *attitudinal acceptance* as well as the *perceived usefulness*, the *financial costs*, and two *social influences*. Furthermore, through the *attitudinal acceptance*, farmers' *affect* associated with the use of the technology influences *intentional acceptance*.

Additional analyses suggest that managers may improve the acceptance of Swath Control Technology for Planters by improving, among other factors, farmers' *perceptions of facilitating conditions* (the availability of instruction and assistance) and farmers' *knowledge* about the technology. Both will influence the *perceived compatibility* and *complexity*, which in turn are important drivers of the *perceived usefulness* and *ease of use*, which influence *acceptance*.

Finally, we find that the internal predictive validity of our model is high - the percentage of correctly predicted choices (yes/no acceptance) is 91.1%. A more rigorous test of the predictive validity of the model confirms the value of the model for predicting acceptance. We find that we could ask a new sample of corn growers to only answer questions on the key determinants of technology acceptance, as specified in our model, and predict with an 88.3% accuracy whether these corn growers would state that they will or will not accept the Swath Control Technology for Planters.

Overall, we conclude that our model for predicting the acceptance of new technologies has a high predictive validity. Furthermore, the model provides managers with directions for influencing the acceptance of technologies.

Chapter 1 – Understanding Technology Acceptance

Background and Overview

Given that the success rate of new product and technology development (from initial ideas to launch) is relatively low, it is important that those products and technologies that do make it to launch will be accepted in the market place. Research to increase the understanding of customer acceptance of new products and technologies is widespread and scattered. Researchers from psychology, sociology, information technology, organizational behavior, economics and marketing all have examined the determinants of new product and technology acceptance with mixed success. The mixed success, in our opinion, has been due to a lack of integration of research findings and the absence of a theory supporting a predictive model of acceptance of technology. The objective of this research project is to develop a predictive model to help improve the quality of the decision-making process and reduce the uncertainty when considering new technologies for product development programs. An overview of our research team is presented in Appendix A. We proposed a three-phase approach described below.

Summary of Phase I (FY 05) – Developing a Qualitative Model

The primary purpose of Phase I was to develop a conceptual model based on an extensive review of multiple literatures (diffusion research, marketing research, psychology research, etc.). From this research we determined those variables likely to be critical to technology acceptance and the probable inter-relationships among them. We also identified variables that were ill defined and needed to be investigated further as well as gaps in the literature. Furthermore, Phase I laid the foundation for a quantitative assessment of technology acceptance.

A conceptual model (also called a qualitative model):

- provides a non-mathematical description of variables and their interactions to motivate further understanding of a phenomenon (in this case – technology acceptance)
- identifies the critical variables in an area
- specifies the relationships between the variables
- identifies research gaps
- provides the crucial foundations for the formulation of testable hypotheses and the development of quantitative models

We began this Phase I on January 10, 2005. We developed a multi-phased process for the literature review whereby we first identified the problem space and the relevant search terms to define the research boundaries. We then identified the relevant journals with the highest impact in the fields of marketing, psychology, economics, management, and information technology. We conducted a computer-assisted search of the citations of these journals using the following keywords: technology, new product, innovation, acceptance, user acceptance, adoption, rejection, diffusion model, Bass model, and technology acceptance model (as well as combinations of these keywords). Relevant citations were pulled into the Endnote bibliographic management system, and the articles were retrieved to be manually reviewed . Each article was analyzed and classified along the following dimensions relevant to our model development: acceptance definition, outcome measures, other variables, environment, and method notes. We completed the literature review and developed a qualitative model.

In sum, the primary outcome of Phase I was a qualitative model based on an extensive review of multiple literatures identifying critical variables and their purported interrelationships. This evaluation helped identify variables that were ill defined and needed to be investigated further. It also provided the initial framework for specification of the critical variables that must be assessed in a quantitative analysis of technology acceptance. Our review also provided insights relevant to design and marketing. We formally finished Phase I on February 2, 2006 with a presentation of the final report to *Deere & Company* and provision of a detailed technical report which is available on *JD Mindshare*:

Van Ittersum, K., Rogers, W. A., Capar, M., Caine, K. E., O'Brien, M. A., Parsons, L. J., & Fisk, A. D. (2006). *Understanding technology acceptance: Phase 1 – literature review and qualitative model development* (HFA-TR-0602). Atlanta, GA: Georgia Institute of Technology, School of Psychology, Human Factors and Aging Laboratory.

Summary of Phase II (FY 06) – Developing a Battery of Metrics and Preliminary Testing of a Quantitative Model

We started Phase II (FY06) on January 1, 2006. There were three main components of Phase II. First was the development of a database of measures for each of the constructs identified in the Phase I model. To that end, we developed an operational definition (i.e., a measurable meaning) for each of the variables. We then identified available metrics that have been validated in the research literature and developed a searchable computer program that enables *Deere & Company* to easily identify what measures are available, how reliable these measures are, and what questions need to be asked to measure the construct under consideration.

The second component of Phase II was to determine which measures are most appropriate for our model development regarding their relevance to *Deere* products. This process required the revision of the measures to suit the specific requirements of *Deere* products. The outcome of this aspect of Phase II is a battery of metrics available to Deere for testing critical variables relevant to their products.

The third major aspect of Phase II was the pretesting of a quantitative model. We developed a questionnaire instrument that was tested first with subject matter experts and then administered to customers. We assessed technology acceptance retrospectively; that is, we queried both adopters and nonadopters about their decisions related to products that have already been deployed. This preliminary questionnaire enabled us to test the reliability and the validity of the metrics we have developed as well as to identify gaps in the quantitative model.

We assessed the validity of our initial quantitative model for two products from two technology categories: Hybrid Technology and Intelligent Mobile Equipment. We selected one product that has been very successful (i.e., widely adopted) and another that has been less successful in terms of its rate of adoption. We worked closely with the Deere & Company members of the team to identify the most suitable products and to develop a sampling frame of customers to receive the surveys. The details of the model are available on JD Mindshare:

Van Ittersum, K., Rogers, W. A., Capar, M., Park, S., O'Brien, M. A., Caine, K. E., Parsons, L. J., & Fisk, A. D. (2006). *Understanding technology acceptance: Phase II – Identifying and validating metrics and preliminary testing of a quantitative model* (HFA-TR-0604). Atlanta, GA: Georgia Institute of Technology, School of Psychology, Human Factors and Aging Laboratory.

Van Ittersum, K., Rogers, W. A., Capar, M., Park, S., Caine, K. E., O'Brien, M. A., Parsons, L. J., & Fisk, A. D. (2007). *Understanding technology acceptance: Phase II (Part 2) – Refining the quantitative model* (HFA-TR-0704). Atlanta, GA: Georgia Institute of Technology, School of Psychology, Human Factors and Aging Laboratory.

These reports present all the quantitative analyses conducted to examine the predictive validity of a Technology Acceptance Model that was constructed based on the results of Phase I of this research project. Based on a pre-study 1 on GPS cell phone technology, we significantly reduced the number of questions that needed to be asked to be able to estimate our model (Van Ittersum et al., 2006). Next, we tested the model among a sample of superintendents of US golf courses with regard to a Hybrid Riding Mower. Furthermore, a sample of US farmers was approached regarding an Autoguidance System. Extensive analyses revealed some interesting insights into the acceptance process among real managerial decision makers. The analyses, however, also revealed some limitations of the original model. Besides some statistical anomalies, we realized that the variables in the model could be reorganized such that the value of the model increased at only a minimal cost with respect to the predictive validity. The data were reanalyzed and the final model is presented in Figure 1.1.

We believe that this refined model provides insights into the variables that predict technology acceptance attitudes, intentions, and behaviors. This model served as the basis for the Phase III prediction of a new technology to be introduced by Deere & Company in the latter part of 2007. Moreover, the format of the model illustrates the causal relationships amongst the critical variables. Consequently, a second objective of Phase III is to investigate these causal relationships in more depth (see Rogers et al., 2007).

Specific Goals and Objectives of Phase III

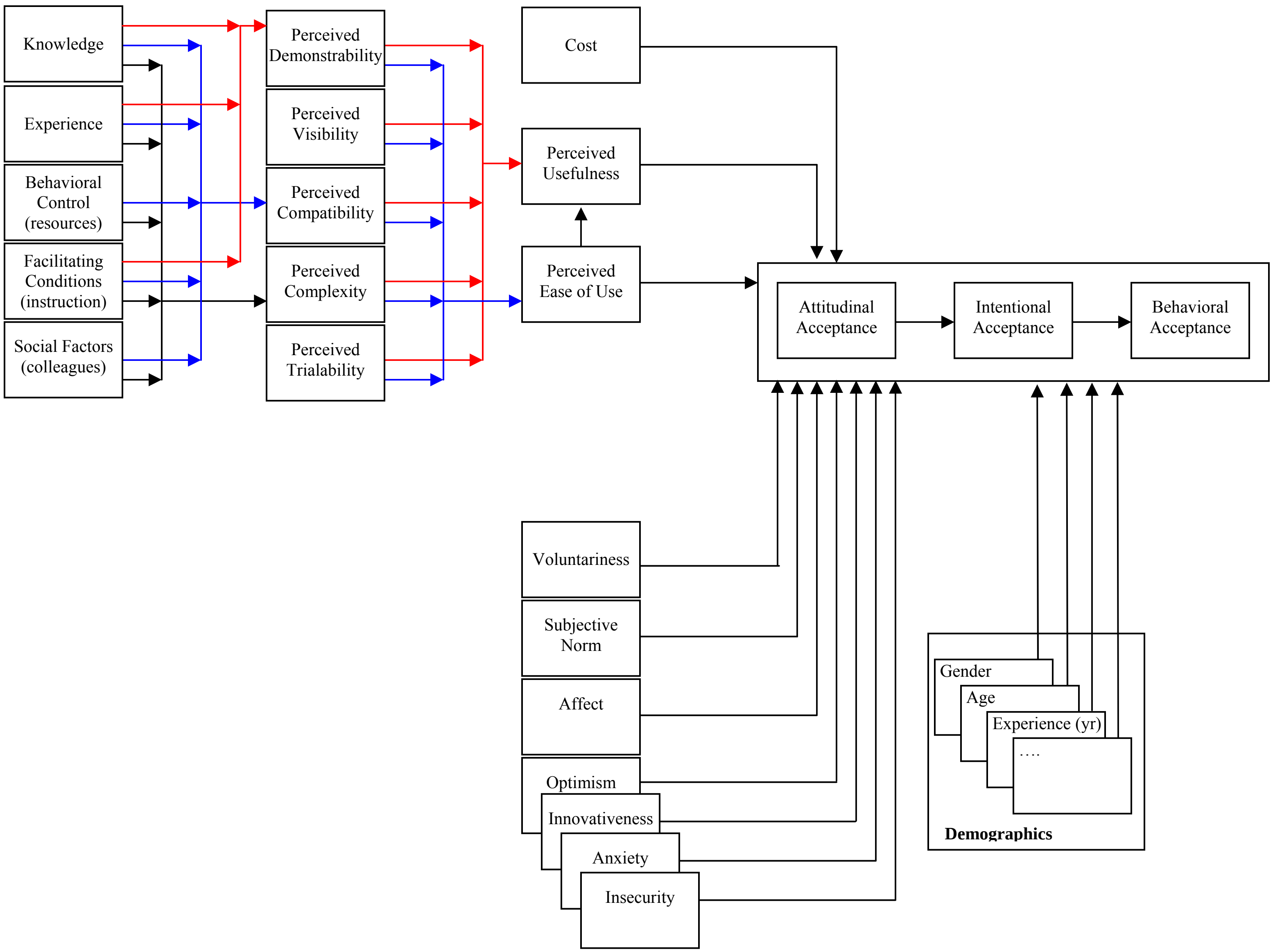
The objectives of Phase III of this project are to (1) use the quantitative model shown in Figure 1.1 to predict technology acceptance; and (2) empirically assess communication methods for conveying product information that will increase acceptance by different customer segments.

The outcomes of Phase III are (1) a set of predictions on the (timing of the) acceptance of the new *Deere & Company* technology; and (2) insights into communication strategies that facilitate the acceptance of technologies in the market place (see Rogers, Fisk, Caine, Kwasny, Wilkison, Mayer, and Van Ittersum (2007).

Phase III (FY 07) – Validating the Quantitative Model

In contrast to the retrospective prediction used in Phase II, the quantitative modeling in Phase III takes a prospective approach. Instead of testing the model based on what happened in

Figure 1.1. An Updated Technology Acceptance Model



the past (Phase II), we examine its predictive power by predicting the market performance of a technology introduced by *Deere & Company* in 2007. We timed this study pre-launch publicity and advertising of a new *Deere* technology and use our model to predict which customers are more likely to accept. This allowed us to provide the study participants with an objective, detailed description of the technology and what it can do, without allowing other factors to interfere in the research process. To maximize the usability of the insights obtained in Phase II, the selected new *Deere* technology was comparable to one of the technologies studied in Phase II.

The proposed plan for Phase III was to be predictive about the acceptance of the selected technology in the *Deere & Company* target market for the selected technology. We used our quantitative model, developed a survey instrument, sent a survey to more than 5,000 prospective customers in the target market of the new technology, and used the insights obtained to predict technology acceptance. To actually test the external predictive ability of our model, we need actual market performance information on the technology under consideration; that is, actual sales data on who did accept and who did not (yet). Since these data are not readily available in Phase III, we examined the internal predictive validity by estimating our entire model based on 60% of those prospective customers, who completed the survey questionnaire and used the outcome to predict the self-reported acceptance of the other 40% of prospective customers in our sample. Combined with the external validity information obtained in Phase II, this gives us a reasonably accurate idea about the predictive ability of our model. To test the external predictive validity of our model based on actual market performance data, the project needs to be extended beyond Phase III (see Chapter 4).

Chapter 2 – Validating the Quantitative Model of Technology Acceptance: Swath Control Technology for Planters

Technology Selection

To test the predictive validity of the acceptance model, we planned to study it for a technology that was not yet introduced in the market place. We identified the following criteria that a technology needed to meet for it to be considered:

- *New technology in the product category*
- *Technology introduction during last 3 months of 2007, or first 3 months of 2008, introduced in the USA*
- *Nation-wide or a regional introduction*
- *Well-defined and identifiable target market (consisting of at least 4000-5000)*
- *No contamination of target market (e.g., marketing action during first half of 2007).*

In close collaboration with *Deere & Company*, several potential technologies were identified and considered (e.g., Soil Information Systems, TMC electrohydraulic backhoes, JDLink). After careful consideration it was decided to test the model for Swath Control Technology for Planters. Swath Control Technology for Planters is a technology that uses GPS while planting seeds for row crops to minimize planting overlap and gaps. It automatically engages/disengages individual or groups of planter row units to minimize overlap and gaps, based on where you are in the field relative to where you have already planted.

This technology matched most of the criteria under consideration: 1) it was a new technology in the product category (the technology was already available on sprayers), 2) the technology would be introduced towards the end of 2007 (press release was sent out on August 23, 2007 to announce the technology would be available for the 2008 planting season:

http://www.deere.com/en_US/newsroom/2007/releases/farmersandranchers/-082307_swath.html), 3) it was a nationwide introduction, 4) the technology has a well-defined and identifiable target market, and 5) there was virtually no contamination of the target market prior to us being able to survey the target market.

Method

To test the quantitative model for Swath Control Technology for Planters, we modified our questionnaire from Phase II with respect to this technology. The details of this questionnaire can be found in Appendix C. On the first page of the questionnaire a description of the Swath Control Technology for Planters was provided. This description was developed in close collaboration with experts at *Deere & Company*.

> *Swath control technology for planters is a technology that uses GPS while planting seeds for row crops to minimize planting overlap and gaps. It automatically engages/disengages individual or groups of planter row units to minimize overlap and gaps, based on where you are in the field relative to where you have already planted. The estimated price for this technology is $13,500.*

The questionnaire was designed to measure a wide variety of variables found in the literature as well as acceptance of Swath Control Technology for Planters. The order of items was randomized.

In addition to the questionnaire, we prepared a cover letter and a consent form. The cover letter explained the objectives of the survey, why they were asked to participate, how they were contacted, the terms of privacy, how much time it takes to complete the questionnaire, how to enter the sweepstakes, how to return the completed questionnaires, and whom to contact for their questions. The survey was distributed by the Survey Research Center at The University of Georgia. Participants were offered the opportunity to enter a sweepstakes for a $50 gift certificate to be given to a total of fifty participants.

To test the predictive validity of our acceptance model, a representative sample was drawn from the target market of the technology. In close collaboration with Deere experts, it was decided that corn growers with farms of 500+ acres of corn represent the target market of the Swath Control Technology for Planters. Based on a publicly available database, a random sample of 5,005 US corn growers with farms of 500+ acres was drawn.

Two weeks before sending out the questionnaire, all participants received a pre-notification letter informing them about the upcoming study. Next, the questionnaire, along with the other documents (consent form, cover letter, and sweepstakes entrance form), was sent to these 5,005 US farmers. Participants were given four weeks to fill out the questionnaire and to send it back to us. Two weeks after the questionnaires were sent all participants who had not yet responded were sent a reminder note. Six weeks after the first wave of questionnaires was sent out, a second wave was sent out to those participants who had not yet responded. These participants were given another four weeks to return their questionnaire. At the end of the second wave, it was concluded that 89 questionnaires were undeliverable, bringing the total number of deliverable questionnaires to 4,916. With a total of 579 participants responding, the final response rate was 11.8%.

We examined the extent to which non-response may have influenced the representativeness of our sample. First, there were 49 participants who sent the questionnaire back explaining why it would be inappropriate for them to participate. The most important reasons were retirement and outsourcing this farming (planting) activity. We also examined if early respondents differed in any way from late responders. As no differences were found, we conclude that non-response biases have remained minimal.

To test the external predictive validity accurately, we propose to recontact the farmers in our sample in a possible Phase IV of the Deere acceptance project. To be able to connect the responses of this survey and those that may be conducted in Phase IV, a unique code was created for each farmer, thus we know exactly who indicated acceptance of the Swath Control Technology for Planters and we can determine in Phase IV if that individual actually did purchase the technology.

On the following pages, information on the scales used to validate the technology acceptance model is presented. More specifically, for each construct, the exact items used in the survey are presented. Furthermore, the internal reliability, the degree to which these items relate and measure the same construct, is presented.

Dependent Variables

The dependent variables were attitudinal acceptance, intentional acceptance, and behavioral acceptance. Table 2.1 shows the items we used to measure the dependent variables, and the response scales corresponding to these items.

Table 2.1. Measurement of Dependent Variables – Swath Control Technology for Planters

Dependent Var.	Items	Response Scale	Reliability
Attitudinal Acceptance	Please indicate what your attitude is towards Swath Control Technology for Planters, relative to traditional steering, by circling the appropriate responses	1=Bad, 5=Good 1=Unfavorable, 5=Favorable 1=Negative, 5=Positive	.96
Intentional Acceptance	Please indicate what your intention is to buy Swath Control Technology for Planter	1=No intention, 5=Strong intention 1=Unlikely, 5=Likely	.98
Behavioral Acceptance	Will you buy Swath Control Technology for Planter	Yes-No	n/a

Independent Variables.

Table 2.2 shows the items we used to measure the independent variables and the response scales corresponding to these items. Furthermore, the internal reliability is presented.

In addition to the items presented in Table 2.1 and Table 2.2, we asked the respondents questions about their awareness of Swath Control Technology for Planters, how much experience they have with operating planters with and without Swath Control technology, and for instance how much experience they have operating Swath Control Technology for *Sprayers* (1 = I have no experience; 5 = I have a lot of experience). Furthermore, respondents were asked for demographic information regarding themselves as well as their farm (e.g., age, gender, size of staff, budget for equipment, and annual gross farm revenue). Finally, we asked them about the perceived shape and obstacles associated with their fields. The exact details of these and several other questions and scales can be found in Appendix C.

Table 2.2. Measurement of Independent Variables – Swath Control Technology for Planters

Construct	Items	Response Scale	Reliability
Technology Characteristics			
Ease of Use	Learning to operate an Swath Control Technology for Planters would be easy for me It would be easy for me to become skilful at using an Swath Control Technology for Planter I would find an Swath Control Technology for Planters easy to use	1=Strongly Disagree, 5=Strongly Agree	.85
Complexity	Using an Swath Control Technology for Planters would take too much time from my normal activities Working with an Swath Control Technology for Planters would be so complicated, it would be difficult to understand what is going on Using an Swath Control Technology for Planters would involve too much time doing mechanical operations	1=Strongly Disagree, 5=Strongly Agree	.78
Compatibility	Using an Swath Control Technology for Planters is compatible with all aspects of my work Using an Swath Control Technology for Planters fits well with the way I like to work Using an Swath Control Technology for Planters fits into my work	1=Strongly Disagree, 5=Strongly Agree	.86
Trialability	I can use an Swath Control Technology for Planters on a trial basis to see what it can do It is easy to try out the Swath Control Technology for Planters without a big commitment I have had opportunities to try out the Swath Control Technology for Planter	1=Strongly Disagree, 5=Strongly Agree	.44
Observability/Visibility	One sees Swath Control Technology for Planters on many farms The Swath Control Technology for Planters is not very visible on my farm	1=Strongly Disagree, 5=Strongly Agree	.32
Result Demonstrability	I have no difficulty telling others about the results of using an Swath Control Technology for Planter I believe I could communicate to others the consequences of using an Swath Control Technology for Planter The results of using an Swath Control Technology for Planters are apparent to me I would have difficulty explaining why using the Swath Control Technology for Planters may or may not be beneficial	1=Strongly Disagree, 5=Strongly Agree	.77
Voluntariness	The use of the Swath Control Technology for Planters is voluntary I am not required to use the Swath Control Technology for Planter Although it might be helpful, using an Swath Control Technology for Planters is certainly not compulsory in my job	1=Strongly Disagree, 5=Strongly Agree	.58

Table 2.2. Measurement of Independent Variables – Swath Control Technology for Planters (-continued-)

Perceived Usefulness	Use of an Swath Control Technology for Planters can increase the effectiveness of performing tasks and activities Using an Swath Control Technology for Planters improves the quality of my work Using an Swath Control Technology for Planters increases my productivity If I use an Swath Control Technology for Planter, I increase the quality of output	1=Strongly Disagree, 5=Strongly Agree	.88
Cost	It would cost a lot to use an Swath Control Technology for Planter There are financial barriers to me using an Swath Control Technology for Planter	1=Strongly Disagree, 5=Strongly Agree	.57
User Characteristics			
Optimism	I prefer to use the most advanced technology available I like computer programs that allow me to tailor things to fit my own needs Technology makes me more efficient in my occupation	1=Strongly Disagree, 5=Strongly Agree	.69
Technology Anxiety	Technical support lines are not helpful because they don't explain things in terms I understand There is no such thing as a manual for a high-tech product or service that is written in plain language When I get technical support from a provider of a high-tech product or service, I sometimes feel as if I am being taken advantage of by someone who knows more than I do	1=Strongly Disagree, 5=Strongly Agree	.66
Innovativeness	I can usually figure out new high-tech products and services without help from others I enjoy the challenge of figuring out high-tech gadgets I find I have fewer problems than other people in making new technology work for me	1=Strongly Disagree, 5=Strongly Agree	.77

Table 2.2. Measurement of Independent Variables – Swath Control Technology for Planters (-continued-)

Insecurity	I do not consider it safe giving out a credit card number over a computer I do not consider it safe to do any kind of financial business online I worry that information I send over the internet will be seen by other people	1=Strongly Disagree, 5=Strongly Agree	.80
Knowledge	I have a lot of knowledge about Swath Control Technology for Planters I am very familiar with Swath Control Technology for Planters	1=Strongly Disagree, 5=Strongly Agree	.88
Social Factors	My colleagues will be helpful in the use of an Swath Control Technology for Planter My colleagues will be very supportive of the use of an Swath Control Technology for Planters for my job In general, my colleagues will support the use of an Swath Control Technology for Planter	1=Strongly Disagree, 5=Strongly Agree	.87
Subjective Norm	I think that people who influence my behavior think that I should use an Swath Control Technology for Planter I think that people who are important to me think that I should use an Swath Control Technology for Planter	1=Strongly Disagree, 5=Strongly Agree	.78
Behavioral Control	I have the resources necessary to use an Swath Control Technology for Planter We have the knowledge necessary to use an Swath Control Technology for Planter In light of the resources, opportunities, and knowledge required to use an Swath Control Technology for Planter, it would be easy for me to use an Swath Control Technology for Planter	1=Strongly Disagree, 5=Strongly Agree	.77
Experience	I do not have much experience using Swath Control Technology for Planters	1=Strongly Disagree, 5=Strongly Agree	n/a
Facilitating Conditions	Specialized instruction concerning an Swath Control Technology for Planters will be available to me Assistance will be available to deal with system difficulties	1=Strongly Disagree, 5=Strongly Agree	.76
Affect	I would think using an Swath Control Technology for Planters is pleasant I would find working with an Swath Control Technology for Planters to be fun I would like working with an Swath Control Technology for Planter	1=Strongly Disagree, 5=Strongly Agree	.86

Sample Characteristics

Before discussing the results, we will describe the sample. We discuss farmer demographics, farm demographics, farm operations, and Swath Control Technologies.

Farmer Demographics. The majority of the participants were male (99.4%) with an average age of 53.5 years. About 9% of the participants range from 18 to 35 years, 27.7% range from 36 to 50 years, 47.7% range from 51-65 years, 15.1% range from 66 to 80, while 0.6% of the participants were over 80- years. The participants have 35.1 (min. = 5; max. = 80) years of work experience in the agricultural industry. Over 60% of the participants have a minimum "some college/associate's degree."

Close to 50% of the participants belong to a local farm organization, 32.2% belong to a regional farm organization, and 39.3% belong to a national farm organization.

Farm Demographics. Most of the participants, 83.4%, farm in the Midwest or on the Plains. Table 2.3 shows that the participants closely resemble the total target market with respect to where they farm.

Table 2.3. Geographic Location of Our Respondents Relative to the Total Target Market

Geographical Location	Total Target Market	Respondents
South	6.2%	5.8%
East Coast	3.0%	4.5%
Midwest/Plains	88.7%	83.4%
West Coast	2.1%	6.4%

The average size of the participants' farms is 3,600 acres (min = 500; max = 30,000 acres). More specifically, 15.4% farm on 500-1,500 acres, 28.8% farm on 1,500-2,500 acres, 20.1% farm on 2,500-3,500 acres, and 35.7% farm on more than 3,500 acres. Five percent (23) of the participants farm on 10,000 acres or more. The most important crops for these farmers are corn (>70%), soybeans (>50%), and wheat (>25%). On average, our participants report growing 1,748 acres of corn. Table 2.4 shows that our sample of respondents contains a relative high percentage of larger corn growers. The percentage of corn growers growing between 1,500 and 3,500 acres of corn per year is overrepresented compared to smaller growers. While unintended, this sample characteristic allows for a closer examination of the effect of the size of production on the acceptance of Swath Control Technology for Planters.

Table 2.4. Corn Production of Our Respondents Relative to the Total Target Market

Acres of Corn	Total Target Market	Respondents
500-1,500	91.6%	52.8%
1,500-2,500	5.8%	28.5%
2,500-3,500	1.6%	10.2%
> 3,500	1.0%	8.6%

On average, the participants own planters with 17 rows. The average rating of the shape of their fields (1 = very irregular; 5 = very regular) is 3.34 (min = 1; max = 5). Almost 26% of the participants report that their fields are irregular to very irregular. The average number of obstacles associated with their fields (1 = many obstacles; 5 = no obstacles) is 3.60 (min = 1; max = 5). Only 15% of the participants associate many obstacles with their fields.

Almost two-thirds of the participants (62.7%) report an annual budget for equipment of between \$50,000 and \$199,999. Almost seventeen percent (16.7%) report an annual budget of more than \$199,999. Likewise, 61.1% of the participants report an annual gross farm revenue of between \$500,000 and \$1,999,999. Twenty five percent (25.0%) report kmaverage annual gross farm revenue of over \$200,000.

On average, the participants employ 3.1 full time employees (min. = 0; max. = 50) and 2.7 (min. = 0; max. = 50) part time employees. As expected, most participants (87.1%) report that their families work with them on the farm and that the family members are involved in farm equipment purchase decisions (81.1%). On average, 2.3 persons are involved in purchase decisions of farm equipment.

Farm Operations. More than 50% (58.9%) of the participants report that they have expanded their operations, in acres, in the last five years by an average of 809.8 acres. Nearly sixty-four percent of the respondents (63.7%) report that they plan to grow their operation, in acres, in the next five years by an average of 818.8 acres.

While 52.9% of the participants report that they have a time horizon of more than one year when making plans that affect their farming operation, the other half has a 3 to 12 months time horizon.

Seventy-seven percent of the participants report owning/using a GPS received system, 55.9% report owning/using an autoguidance system, 40.1% report owning/using Swath Control Technology for *Sprayers*, 84.6% report owning/using a yield monitor, and 47.6% report owning/using grid soil sampling.

Swath Control Technology. More than three quarters of the participants (77.6%) report that they were aware of Swath Control Technology for Planters prior to this survey. They first learned about the technology 18.4 months ago. Twenty-six percent (26.0%) of the participants claimed they learned about the technology through the media; 30.7% learned about it from the distributor; and 19.4% learned about it through other channels (including crop consultants, dealers, and other farmers).

Considering that this is a new technology in the context of planters, we suspect that the high awareness level is driven by the availability of the technology for pesticide sprayers. To explore this notion we examined if ownership of Swath Control Technology for *Sprayers* relates to the awareness question. In line with expectations we find that those who own Swath Control Technology for Sprayers are much more likely to claim that they are aware of Swath Control Technology for Planters (88.5% versus 71.2%; $\chi^2 = 18.9$; $p < .01$).

On average, the participants have a lot of experience (1 = I have no experience; 5 = I have a lot of experience) with operating planters without Swath Control Technology, Mean = 4.6. As to be expected, experience with operating planters with Swath Control Technology is low, M = 1.6, The amount of experience with installing and operating Swath Control Technology for sprayers also remains fairly low ($M_{installing} = 1.8$, $M_{operating} = 2.4$). Experience with GPS guidance systems is fairly high (M = 3.6).

When asked for which crops they would use Swath Control Technology, corn (> 70%), and soybeans (> 40%) were mentioned most often. Crops for which the participants were least likely to use the technology are wheat (± 15%) and a wide variety of other crops.

Results

Before presenting the number of farmers who stated that they will accept (buy) Swath Control Technology for Planters, we discuss the estimation results of our technology acceptance model, which was developed during Phase II of the project. These estimates will inform us about the key determinants of farmers' acceptance of Swath Control Technology for Planters.

Acceptance Predicted. We used Ordinary Least Squares (OLS) regression analyses as well as logistic regression analyses to examine our model (Figure 1.1). Note that we first examine the model across all participants, before testing the predictive validity in more detail.

The results are presented in Table 2.5. We will discuss the results for each model (M1-M3) separately.

Table 2.5. Regression Results Swath Control Technology for Planters

	Dependent Variables		
Independent Variables	**M1 Attitudinal Acceptance[a]**	**M2 Intentional Acceptance[a]**	**M3 Behavioral Acceptance[a]**
Attitudinal Acceptance		.267***	.492*
Intentional Acceptance			3.462***
Technology Characteristics			
Perceived Usefulness	.410***	.356***	.498*
Ease of Use	.037	-.046	.104
Cost	-.035	-.103***	.531
User Characteristics			
Voluntariness	.048	-.082**	-.263
General Anxiety	.021	-.037	-.333
Optimism	.026	.019	.120
Innovativeness	-.057	-.020	.056
Insecurity	-.026	.025	.197
Social Force	.035	.086**	.192
Affect	.214***	.017	-.081
Gender	-.056	-.045	-2.03
Age	-.090	-.036	-.022
Years of Experience	.032	.011	.014
Farm Size (acres)	-.00	.032	.000
Aware of Technology	.123***	.178***	.551
R-square	.432	.644	.791
F-value	20.23	44.97	174.29

[a] Attitudinal and Intentional acceptance results are based on OLS. Behavioral acceptance results are based on logistics regression. Hence, the path-coefficients cannot be compared. * $p < .10$, ** $p < .05$, *** $p < .01$ (two-tailed)

As Table 2.5 shows, the *attitudinal acceptance* of Swath Control Technology for Planters (M1) is largely driven by the *perceived usefulness* of the technology. This component is by far the most important determinant of the *attitudinal acceptance*. Additionally, participants' *affect*, their positive emotions associated with operating this technology, influences *attitudinal acceptance*. Finally, participants' *awareness* of the technology influences *attitudinal acceptance*.

The *intentional acceptance* of the Swath Control Technology for Planters (M2) is largely driven by farmers' *attitudinal acceptance* and the *perceived usefulness* (i.e., directly and indirectly through the attitudinal acceptance). Besides the positive influence of the *perceived usefulness*, we find a negative effect of the *perceived costs* on intentional acceptance of Swath Control Technology for Planters. Furthermore, two related social aspects influence *intentional acceptance*. First, the more *voluntary* the use of technology is in daily operations (i.e., are they forced to use it), the lower farmers' *intentional acceptance*. However, the more they feel that people important to them think they should use the technology – the higher the *subjective norm*, the higher their *intentional acceptance*.

Lastly, the *behavioral acceptance* of the Swath Control Technology for Planters (M3) is primarily driven by the intentional acceptance. Besides this effect, *attitudinal acceptance* and *perceived usefulness* influence *behavioral acceptance*.

In conclusion, the *behavioral acceptance* of Swath Control Technology for Planters is driven by the *intentional acceptance*, which in turn is driven by the *attitudinal acceptance* as well as the *perceived usefulness*, the *financial costs*, and two *social influences*. Furthermore, through the *attitudinal acceptance*, farmers' *affect* associated with the use of the technology influences *intentional acceptance*. Finally, we find that the internal predictive validity is high - the percentage of correctly predicted choices (yes/no acceptance) is 91.1%.

Acceptance Explained. Next, we find that the most important factor influencing farmers' perception of the *usefulness* of the Swath Control Technology for Planters is the *perceived compatibility* (see Table 2.6). Other factors that positively influence perceptions of the *perceived usefulness* are the *ease of use* and the *result demonstrability*. Further, we find that the lower the *rate of irregularities and obstacles*, the lower the *perceived usefulness* of the Swath Control Technology for Planters. Lastly, a small effect for field character is found – the more their fields are characterized by irregularities and obstacles, the more useful Swath Control Technology for Planters is perceived to be.

Furthermore, we find that increased perceptions of *complexity* reduce the *perceived ease of use*, while more favorable perceptions of *compatibility* increase the *perceived ease of use* (see Table 2.6). Finally, both an increased *visibility* of the technology and the *result demonstrability* improve the *perceived ease of use*.

Table 2.6. Regression Results Swath Control Technology for Planters

	Dependent Variables	
Independent Variables	**Perceived Usefulness**	**Perceived Ease of Use**[a]
Ease of Use	.133***	
Complexity	.026	-.341***
Compatibility	.610***	.253***
Trialability	.099**	.070*
Observability/Visibility	.086***	.124***
Result Demonstrability	.188***	.197***
Field character[b]	-.047*	
R-square	.639	.411
F-value	115.49	65.343

[a] *Remember that perceived ease of use does not influence acceptance of Swath Control Technology for Planters.*
[b] *Field character is the sum of two questions: one asking farmers to judge the shape of their fields (1 = very irregular; 5 = very regular), and one asking them to judge how many obstacles their fields have (1 = many obstacles; 5 = no obstacles). The sum of both answers is used as a proxy for the overall character of farmers' fields.*
* $p < .10$, ** $p < .05$, *** $p < .01$ (two-tailed)

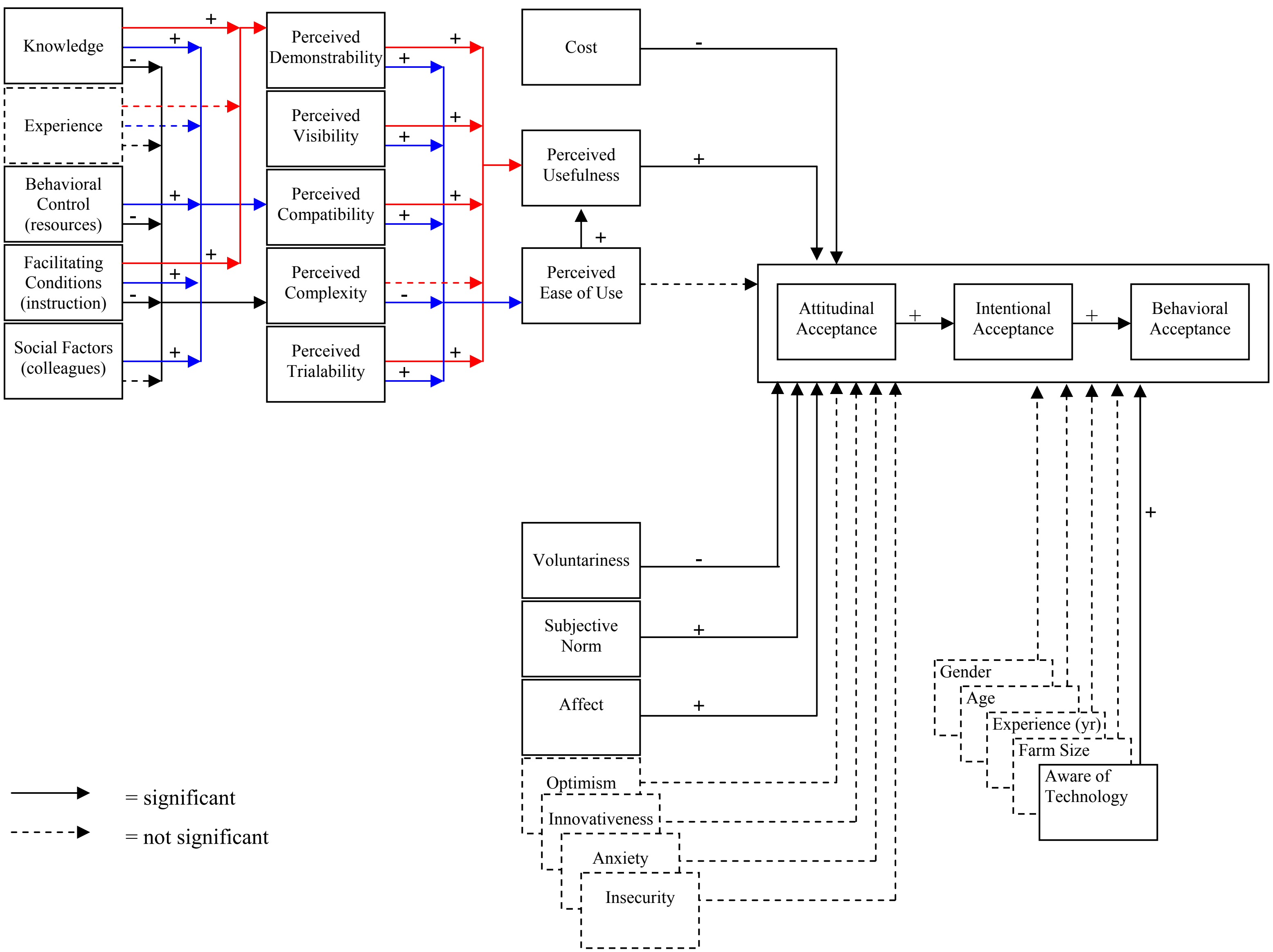
Finally, we examined what drives farmers' perceptions of *compatibility, complexity*, and *demonstrability*. First, we find that perceptions of *social support, facilitating conditions*, and *behavioral control* are the most important drivers of the *perceived compatibility*. The *behavioral control* and *facilitating conditions* are the two factors that have the largest ability to reduce the *perceived complexity* of the technology. Finally, the *facilitating conditions* and farmers' *knowledge* influence the *perceived result demonstrability*. The effects of experience remain small, which is not surprising as the Swath Control Technology for Planters is a new technology. Farmers simply cannot have experienced working with the technology.

Table 2.7. Regression Results Swath Control Technology for Planters

Independent Variables	Perceived Compatibility	Perceived Complexity	Results Demonstrability
	Dependent Variables		
Social Support	.291***	-.850*	
Facilitating Conditions	.349***	-.157***	.368***
Behavioral Control	.306***	-.305***	
Knowledge	.118**	-.074*	.225***
Experience	-.420	.058	-.051
R-square	.421	.295	.278
F-value	65.19	37.48	57.63

These results suggest that managers may improve the acceptance of Swath Control Technology for Planters by improving, among others, the farmers' *perceptions facilitating conditions* – the availability of instruction and assistance and farmers' *knowledge* about the technology. Both will, among other factors, influence the perceived compatibility and complexity, which in turn are important drivers of the *perceived usefulness* and *ease of use*, which influence acceptance. We believe that facilitating conditions and knowledge may be influenced via marketing actions. This may be more complex for behavioral control and social support. We summarized all results in Figure 2.1.

Figure 2.1. Final Results for the Swath Control Technology for Planters



Predictive Validity

On average, the farmers' attitude towards the Swath Control Technology for Planters is high (M = 4.0). This favorable attitude does translate in a strong intent to accept this new technology – M = 3.4 (which is significantly higher than the scale midpoint of 3). When asked whether they will buy the Swath Control Technology for Planters, 64.4% indicate that they will buy.

However, this percentage of 64.4% most likely is inflated because of the overrepresentation of larger farms in our sample. Larger farms are more likely to buy the technology than smaller ones. The reason farm size (acres) does have a limited influence in the technology acceptance model is that the effect of size is captured by many of the other variables studied. As an example, the perceived usefulness of the Swath Control Technology for Planters is higher among larger farmers than smaller farmers.

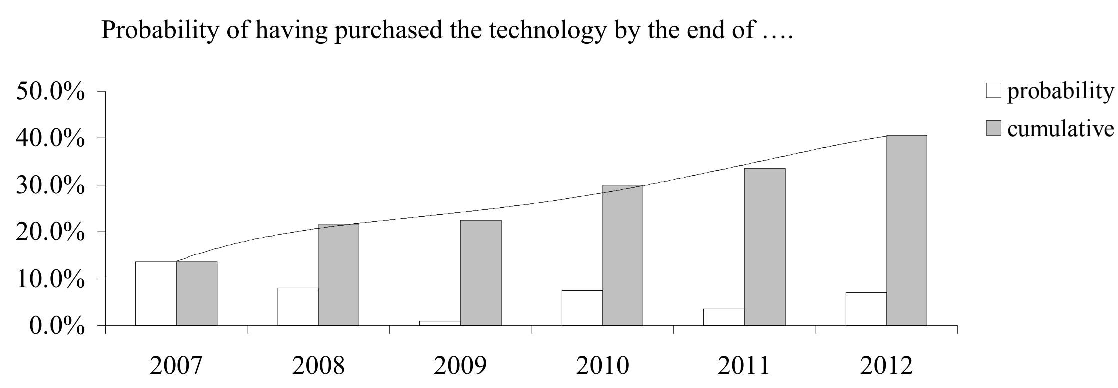
When we correct for the overrepresentation of larger farms in the sample, we find that the corrected self-reported acceptance rate is 59.5% - according to these self-reported behavioral measures, almost 60% percent of the target market plans to buy Swath Control Technology for Planters.

As described, the predictive validity of our model is high – the percentage of correctly predicted choices (yes/no acceptance) is 91.1%. This percentage means that the model is 91.1% accurate in predicting who is likely to accept (64.4%) and who is not likely to accept (35.6%).

To examine the predictive validity more rigorously, we decided to examine the out-of-sample predictive validity by estimating our entire model based on 60% of our sample and use the outcome to predict the self-reported acceptance of the other 40% of prospective customers in our sample. The predictive validity of the model remains high. We find that, when we estimate our model for 60% of our sample and use the model estimates to predict the self-reported behavior of the other 40%, the percentage of correctly predicted choice (yes/no accept) is 88.3%. This means that we could ask a new sample of corn growers to only answer questions on the variables presented in Table 2.5, and without asking them if they would accept the technology we would be able predict with an 88.3% accuracy whether these corn growers would state that they will or will not accept the Swath Control Technology for Planters. This suggests that our model has great predictive validity. Note that a more rigorous test of the predictive validity is to test the model predictions against actual behavior which is what we have proposed in Phase IV of the project.

To gain some sense about *when* they will accept the technology, participants were asked to indicate the probability that they will have bought the new technology by the end of 2007, 2008, 2009, 2010, 2011, and 2012. As we do not know exactly what self-reported percentage translates into real behavior (people may report a probability of only 70% but yet buy the technology), we will use the 100% level as a conservative cut-off level. Figure 2.2 shows the percentage of participants who indicate with a probability of 100% that they will have bought Swath Control Technology for Planters in the coming years.

Figure 2.2. Acceptance of Swath Control Technology for Planters in Time



These results suggest a steady growth of acceptance of Swath Control Technology for Planters in the coming years. Considering the 100% cut-off level used, these results are considered conservative.

To learn more about what influences farmers' decision to accept sooner or later, we used this classification to explore if and how farmers who report they will buy Swath Control Technology in a particular year differ from those farmers who report they will buy the technology some other time. Please note that these results are explorative as statistical challenges prevent us from more elaborately reporting on factors driving the timing of the acceptance of new technologies.

A wide variety of aspects differentiate early from late adopters. Some examples are the perceived usefulness and ease of use. The more useful Swath Control Technology is perceived to be, the more likely farmers are to accept it sooner. Likewise, the more favorable farmers perceive the ease of use, the more likely it is that they will accept sooner. Many other variables show comparable patterns.

Several statistical challenges prevent us from more elaborately discussing the effects of factors on the timing of the acceptance new technologies. We are currently working on examining drivers of the *timing of acceptance* in more detail.

Chapter 3 – Summary and Conclusions

This report presents the quantitative analyses conducted to examine the predictive validity of a Technology Acceptance Model that was constructed based on the results of Phases I and II of this research project. Based on a pre-study on GPS cell phone technology, we significantly reduced the number of questions that are needed to be asked to be able to estimate our model (Van Ittersum et al., 2006). Next, we tested the model among a sample of superintendents of US golf courses with regard to a Hybrid Riding Mower. Furthermore, a sample of US farmers was approached regarding an Autoguidance System. Extensive analyses revealed some interesting insights into the acceptance process among real managerial decision makers. However, the analyses also revealed some limitations of the original model. Besides some statistical anomalies, we realized that the variables in the model could be reorganized such that the value of the model increased at only a minimal cost with respect to the predictive validity. We believed that this refined model (see Figure 1.1) provides insights into the variables that predict technology acceptance attitudes, intentions, and behaviors. This model served as the basis for the Phase III prediction of a new technology to be introduced by *Deere & Company* in the latter part of 2007: *Swath Control Technology for Planters*.

We surveyed a sample of 5005 US corn growers with 500+ acres of corn regarding their willingness to accept Swath Control Technology for Planters. We received 579 responses, for a response rate of 11.8%. We find that the self-reported acceptance rate of the Swath Control Technology for Planters is 59.5%; that is, according to the self-reported behavioral measures, **sixty percent of the target market plans to buy Swath Control Technology for Planters**.

To gain an understanding of the determinants of the acceptance of the Swath Control Technology, we next tested our technology acceptance model. We find that the *behavioral acceptance* of Swath Control Technology for Planters is driven by the *intentional acceptance*, which in turn is driven by the *attitudinal acceptance* as well as *perceived usefulness*, *financial costs*, and two *social influences*. Furthermore, through the *attitudinal acceptance*, farmers' *affect* was associated with the use of the technology influences *intentional acceptance*.

Additional analyses suggest that managers may improve the acceptance of Swath Control Technology for Planters by improving, among other factors, farmers' *perceptions of facilitating conditions* – the availability of instruction and assistance and farmers' *knowledge* about the technology. Both will, among others influence, the *perceived compatibility* and *complexity*, which in turn are important drivers of the *perceived usefulness* and *ease of use*, which influence acceptance.

Finally, we find that the internal predictive validity of our model is high - the percentage of correctly predicted choices (yes/no acceptance) is 91.1%. A more rigorous test of the predictive validity of the model confirms the value of the model for predicting acceptance. We find that we could ask a new sample of corn growers to only answer questions on the key determinants of technology acceptance, as specified in our model, and predict with 88.3% accuracy whether these corn growers would state that they will or will not accept the Swath Control Technology for Planters.

Overall, we conclude that our model for predicting the acceptance of new technologies has a high predictive validity. Furthermore, the model provides managers with direction to influence the acceptance of technologies.

Chapter 4 – Future Research

As mentioned, to be able to more rigorously test the predictive validity of our model, we propose to extend the project with a Phase IV (FY08) wherein we propose to validate the predictive results from Phase III by recontacting study participants from Phase III. This would allow us to see if and how many participants, who claimed they would accept the technology within a year after introduction, actually bought the technology. This could be considered the ultimate test of our model.

Besides asking the participants whether they actually bought the technology, we plan to ask those participants who bought the technology to elaborate upon the most important reasons for buying the technology. We also plan to ask participants who did not buy the technology during the first year of introduction to elaborate upon the most important reasons for this decision. And, when analyzing these data, we will differentiate between four groups of participants (see Figure 1): A) participants who *correctly* informed us in Phase III that they will not buy the technology during the first year of introduction, B) participants who *incorrectly* informed us in Phase III that they will not buy the technology during the first year of introduction (they bought it after all), C) participants who *incorrectly* informed us in Phase III that they will buy the technology during the first year of introduction (though they did not buy it), and D) participants who *correctly* informed us in Phase III that they will buy the technology during the first year of introduction.

Figure 4.1. Expected vs. Actual Behavior Regarding the Acceptance of Technology

		Actual Behavior (Phase IV)	
Expected Behavior (Phase III)		Did not buy	Did buy
	Will not buy	A	B
	Will buy	C	D

These additional questions allow for gaining detailed insights into the reasons why decision makers decided to accept or not to accept the technology after all.

Finally, besides investigating the external predictive validity of our model and studying different communication aspects in the field, we aim to focus part of Phase IV on facilitating the transfer process of findings from this project to date within *Deere & Company*. The three key pillars of this effort are 1) the development of a *Deere*-specific *Technology-Introduction Plan* – a detailed plan describing the chronological steps that *Deere & Company* should go through to optimize the acceptance of new technologies in the market place, 2) the development of software allowing for quick and efficient customization of the key scales for measuring technology and user characteristics that have been found to influence technology acceptance, and 3) the organization of a one day conference towards the end of Phase IV, during which the *Deere*-specific *Technology-Introduction Plan* as well as the scale-customization software will be presented together with other findings from Phases I – IV.

Outcomes of Phase IV

The outcomes of Phase IV of this project are (1) insights into the external predictive validity of our model; (2) detailed insights into the reasons why decision makers decided to accept or not to accept a new technology, allowing for fine-tuning the model; (3) a broader understanding of how different communication strategies influence the acceptance of technologies; (4) a *Technology-Introduction Plan* for *Deere & Company*'s introduction of new technologies in the market place, (5) software allowing for easy customization of scales used to measure technology and user characteristics that influence the acceptance of technologies, and (6) a broader transfer of the results of project Phases I – IV throughout *Deere & Company*.

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Appendix A – Research Team

To accomplish our research goals and objectives, we assembled a team of individuals at Georgia Tech with complementary scientific backgrounds. We also worked closely with individuals from Deere & Company from different sectors of the organization to ensure that the results of our review and subsequent research would have broad relevance.

School of Psychology – Georgia Tech

The psychology group has expertise in the field of human factors (designing for human use). They have experience in evaluation of beliefs and attitudes towards technology by individuals of all ages (e.g., Melenhorst, Rogers, & Caylor, 2001; Mynatt, Melenhorst, Fisk, & Rogers, 2004; Rogers, Meyer, Walker, & Fisk, 1998). They have also conducted extensive research on age-related differences in needs, capabilities, and preferences that influence product use, trust in technology, and acceptance (e.g., Fisk, Rogers, Charness, Czaja, & Sharit, 2004; Hancock, Fisk, & Rogers, 2001; Sanchez, Fisk, & Rogers, 2004).

Name	Highest Degree	Research Focus
Kelly Caine	M.S. in Engineering Psychology, Georgia Institute of Technology	Understanding the capabilities and limitations of older adults with an emphasis on understanding how technology can be used to enhance a person's ability to function in later life.
Arthur (Dan) Fisk	Ph.D. in Experimental Psychology, University of Illinois	Skilled performance and training; similarities and differences across age groups in the attention, learning, and development of skilled performance; translating research to motivate technology design for older adults; application of human automatic information processing and mental workload analysis to training high performance skills.
Marita O'Brien	M.S., Engineering Psychology, Georgia Institute of Technology	Psychological factors that facilitate or impair effective use of technologies; bridging the gap between the practical guidance designers need and the psychological literature on attention, motor control, visual search and other factors.
Sung Park	M.S., in Engineering Psychology, Georgia Institute of Technology, M. S., in Human-Computer Interaction, University of Michigan	Understanding the social dimension of the interaction between humans (users) and virtual humans by considering our understanding of human social interaction from social psychology and communication theory.
Wendy A. Rogers	Ph.D. in Experimental Psychology, Georgia Institute of Technology	Broad issues in skill acquisition, human factors, training, and cognitive aging; technology design and acceptance; the psychology of human-computer interaction

College of Management – Georgia Tech

The team members from the College of Management bring a background in marketing (Koert van Ittersum, Muge Capar) and marketing science (Len Parsons). Dr. Van Ittersum's research focuses on consumer decision-making and choice, and the role of risk attitude and risk perception on consumer risk behavior (e.g., Pennings & Van Ittersum, 2004). Furthermore, as part of a larger project on new product development, Van Ittersum works on improving the identification process of those product attributes consumers deem important (e.g., Van Ittersum, Pennings, Wansink, & Van Trijp, 2004a; 2004b). Dr. Van Ittersum also has an extensive practical background in agriculture and is aware of factors that influence the decision-making process of farmers. Muge Capar is a third year PhD student with an interest in drivers of the acceptance of new products and technologies. Dr. Parsons is an expert on market response models (e.g., Hanssens, Parsons, & Schultz, 2001). His current interests are in marketing productivity and benchmarking (e.g., Parsons 2002).

Name	Highest Degree	Research Focus
Muge Capar	B.S. in Management Science and Engineering, Istanbul Technical University	Technology acceptance
Leonard Parsons	Ph.D. in Industrial Administration, Purdue University	Market mix models; marketing productivity
Koert van Ittersum	Ph.D. in Marketing and Consumer Behavior, Wageningen University, The Netherlands	Consumer decision-making and choice; the role of risk attitude and risk perception on consumer risk behavior; improving the identification process of those product attributes consumers deem important

Appendix B – Definition of Constructs

Characteristic	Definition
Ease of Use	The degree to which the potential adopter expects a technological innovation to be free of effort (Davis, 1996; Moore & Benbasat, 1991)
Complexity	The degree to which an innovation is perceived as difficult to understand and use (Rogers, 2003)
Compatibility	The degree to which an innovation is perceived as being consistent with existing values, needs, and past experiences of potential adopters (Moore & Benbasat, 1991)
Trialability	The degree to which an innovation may be experimented with on a limited basis (Moore & Benbasat, 1991)
Observability & Visibility	The degree to which results of an innovation are visible to others (Rogers, 2003)
Result Demonstrability	The degree to which the benefits and utility of an innovation are readily apparent to the potential adopter (Moore & Benbasat, 1991)
Voluntariness	The degree to which use of an innovation is perceived as being voluntary or of free will (Moore & Benbasat, 1991)
Cost	Price of technology
Usefulness	The extent to which a technology is expected to improve a potential adopter's performance (Davis, 1980, 1996)
Relative Advantage	The degree to which an innovation is perceived to be superior to current offerings (Rogers, 2003)
Privacy	The perception of the privacy that the tech. provides
Value	The difference between perceived benefits and costs of a technology
Fun & Enjoyment	The extent to which using the technology results in enjoyment and perceived fun
Demographics	
Age	Age of the (potential) user
Gender	Gender of the (potential) user
Income	Income level of the (potential) user
Education	Education level of the (potential) user
Training & Experience	Training about (using) the technology & experience with similar technologies

Knowledge & Involvement	Knowledge on the technology/ pre-existing technologies & involvement with the tech
Psychographics	
Technology Readiness	People's propensity to embrace and use new technologies for accomplishing goals in home life and at work" (Parasuraman, 2000; p. 308)
Innovativeness	The predisposition to buy new and different products and brands rather than remain with previous choices and consumption patterns (Steenkamp, Hofstede, & Wedel, 1999)
Trust	Trust refers to trust in the technology provider
Privacy Concerns	Consumers' concerns about whether the information they provide to the technology provider by using its product/service will be protected from others, or whether the technology provider will take advantage of the information they gather through the use of its product/service
Anxiety	Evoking anxious or emotional reactions when it comes to performing a behavior" (Venkatesh, Morris, Davis, and Davis, 2003)
Subjective Norm	The person's perception that most people who are important to him think he should or should not perform the behavior in question (Fishbein and Ajzen 1975, p. 302)

Appendix C – Swath Control Technology for Planters Questionnaire

Swath Control Technology for Planters
QUESTIONNAIRE

Swath Control Technology for Planters Survey

Summer 2007

Survey Conducted by

Georgia Institute of Technology
and
The Survey Research Center
University of Georgia

Dear Sir/Madam,

We are contacting you about a research project that you might be interested in. Here at the Georgia Institute of Technology we are interested in how decisions are made about purchasing new products or technologies. In this specific survey, we are contacting farmers throughout the United States to understand their attitudes towards and experiences with Swath Control Technology for Planters.

We retrieved your name and contact information from a database of farmers in the United States. The survey was developed by researchers at Georgia Institute of Technology, and is being distributed by the Survey Research Center at The University of Georgia. We guarantee confidentiality. All identifying information will be separated from your answers. There will be no way to match the completed questionnaire to a particular person or farm. Only the researchers involved in this study will see the completed questionnaires.

To help us would take an estimated 30 minutes. The survey should be completed by the person who is responsible for making decisions about technology purchases on your farm. We know you are very busy and we appreciate your assistance with this research project.

Whether you (or someone from your farm) completes the survey or not, you have the chance to be entered in a sweepstakes. We will be giving fifty $50 gift certificates. At least 1 out of every 100 people who enter will win. Just complete and return the colored form to enter the sweepstakes.

Also, regardless of whether the survey is completed, we will provide you with a summary of the findings if you are interested. Please indicate on the colored form if you are interested in received a copy of the research results summary.

Please return the questionnaire by **September 1, 2007** in the pre-paid and pre-labeled envelope. If you have any questions or concerns, please contact Dr. Koert van Ittersum (404-385-4884) or Dr. Wendy Rogers (404-894-6775).

Sincerely,

Koert Van Ittersum & Wendy A. Rogers

SWATH CONTROL TECHNOLOGY FOR PLANTERS QUESTIONNAIRE

What do we mean by swath control technology for planters?

<u>Swath control technology for planters</u> is a technology that uses GPS while planting seeds for row crops to minimize planting overlap and gaps. It automatically engages/disengages individual or groups of Planters row units to minimize overlap and gaps, based on where you are in the field relative to where you have already planted. The estimated price for this technology is $13,500.

**** Please note that we are interested in your opinion about using swath control technology for <u>planters</u> and <u>not</u> swath control technology for <u>sprayers</u>.*

1. Were you aware of swath control technology for planters prior to this survey?

☐ **No**

☐ **Yes, I <u>first</u> learned about swath control technology for planters __________ months ago, through…**

☐ the Media

☐ the Distributor

☐ Other - namely ……………………………

2. Please indicate how much experience you have with the following activities and items.

	I have no experience				**I have a lot of experience**
Operating planters <u>without</u> swath control technology	1	2	3	4	5
Operating planters <u>with</u> swath control technology	1	2	3	4	5
Operating swath control technology for sprayers	1	2	3	4	5
Installing swath control technology for sprayers	1	2	3	4	5
GPS guidance systems	1	2	3	4	5

3. Please indicate what your attitude is towards swath control technology for planters, relative to planters without this technology, by circling the appropriate responses.

Bad	1	2	3	4	5	**Good**
Unfavorable	1	2	3	4	5	**Favorable**
Negative	1	2	3	4	5	**Positive**

4. Please indicate what your intention is to buy swath control technology for planters.

No intention	1	2	3	4	5	**Strong intention**
Unlikely	1	2	3	4	5	**Likely**

5. Will you buy swath control technology for planters?

☐ **No** ☐ **Yes**

6. Below you see sixteen moments in time, ranging from "September, 2007" to "December, 2008." Assuming swath control technology for planters can be purchased starting September 1, 2007, please indicate for each month the probability that you will have bought swath control technology for planters by circling the appropriate response.

By the end of….	I will not have bought one									I will have bought one
September, 2007	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
October, 2007	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
November, 2007	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
December, 2007	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
January, 2008	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
February, 2008	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
March, 2008	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
April, 2008	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
May, 2008	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
June, 2008	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
July, 2008	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
August, 2008	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
September, 2008	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
October, 2008	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
November, 2008	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
December, 2008	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

7. Please answer the same question for the next six years. Please indicate for each year the probability that you will have bought swath control technology for planters by circling the appropriate response.

By the end of….	I will not have bought one									I will have bought one
2007	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
2008	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
2009	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
2010	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
2011	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
2012	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

8. Please indicate for each statement about swath control technology for planters to what extent you agree with it or feel it applies to you by circling the appropriate response (relative to planters without this technology).

	Strongly Disagree				Strongly Agree
Use of swath control technology for planters can increase the effectiveness of performing tasks and activities	1	2	3	4	5
I would be concerned about Planters performance when using swath control technology for planters	1	2	3	4	5
Using swath control technology for planters will increase my productivity	1	2	3	4	5
It would cost a lot to use swath control technology for planters	1	2	3	4	5
Learning to operate swath control technology for planters would be easy for n	1	2	3	4	5
I will not be required to use swath control technology for planters	1	2	3	4	5
I would find swath control technology for planters easy to use	1	2	3	4	5
Using swath control technology for planters would take too much time from my normal activities	1	2	3	4	5
I have seen swath control technology for planters on many farms	1	2	3	4	5
Using swath control technology for planters would involve too much time doing mechanical operations	1	2	3	4	5
Using swath control technology for planters would be compatible with all aspects of my work	1	2	3	4	5
I believe I could communicate to others the consequences of using swath control technology for planters	1	2	3	4	5
Using swath control technology for planters would fit into my work	1	2	3	4	5
I consider swath control technology for planters a radically new technology	1	2	3	4	5
The use of swath control technology for planters would be voluntary	1	2	3	4	5
I could use swath control technology for planters on a trial basis to see what it can do	1	2	3	4	5
Using swath control technology for pls would improve the quality of my worl	1	2	3	4	5
I have had opportunities to try out swath control technology for planters	1	2	3	4	5
I will have no difficulty telling others about the results of using swath control technology for planters	1	2	3	4	5
Adding swath control technology to planters is very innovative	1	2	3	4	5
The results of using swath control technology for planters are apparent to me	1	2	3	4	5
Using swath control technology for planters will fit well with the way I like to work	1	2	3	4	5
I would have difficulty explaining why using swath control technology for planters may or may not be beneficial	1	2	3	4	5
Working with swath control technology for planters would be so complicated, it would be difficult to understand what is going on	1	2	3	4	5
Swath control technology for planters is not visible on my farm	1	2	3	4	5
It would be easy for me to become skilful at using swath control technology for planters	1	2	3	4	5
Although it might be helpful, using swath control technology for planters is certainly not compulsory in my job	1	2	3	4	5
Swath control technology for planters is a radical new product	1	2	3	4	5
If I use swath control technology for planters, I increase the quality of output	1	2	3	4	5
There are financial barriers to me using swath control technology for planters	1	2	3	4	5
It is easy to try out swath control technology for planters without a big commitment	1	2	3	4	5

9. Please respond to the following statements regarding your beliefs about the performance of swath control technology for planters (relative to using planters without this technology).

	Strongly Disagree				**Strongly Agree**
Swath control technology for planters will yield quality output	1	2	3	4	5
Swath control technology for planters will cause installation problems	1	2	3	4	5
I will have no problems fixing swath control technology for planters in case of a breakdown	1	2	3	4	5
Using swath control technology for planters will decrease my planting costs due to increased accuracy	1	2	3	4	5
I will feel mentally and physically better at the end of a work day when using swath control technology for planters	1	2	3	4	5
The replacement costs of failed parts of swath control technology for planters will be high	1	2	3	4	5
Adopting swath control technology for planters will require technical training	1	2	3	4	5
I will incur high maintenance costs when using swath control technology for planters	1	2	3	4	5
The benefits of using swath control technology for planters will compensate for its cost	1	2	3	4	5
Swath control technology for planters will perform well on heavy tasks	1	2	3	4	5
The dependence of swath control technology for planters on satellites makes it more vulnerable.	1	2	3	4	5
The benefits of using swath control for planters depend on the shape of my fields: more irregular shapes = more benefits	1	2	3	4	5
Swath control technology for planters will reduce gaps and overlaps, which reduces seed expenses	1	2	3	4	5
Swath control technology for planters will reduce my labor requirement	1	2	3	4	5
Swath control technology for planters reduces operator fatigue, which allows for working longer hours	1	2	3	4	5
It will be relatively easy for me to install swath control technology for planters	1	2	3	4	5
Maintaining swath control technology for planters is difficult	1	2	3	4	5
Diagnosing problems with swath control technology for planters will be easy	1	2	3	4	5
Swath control technology for planters is more beneficial when fields have more obstacles (e.g., trees, ponds)	1	2	3	4	5

10. Considering the potential advantages and disadvantages of swath control technology for planters, please circle the appropriate responses:

	Risky				Not Risky
a. Relative to operating planters without swath control technology, operating planters with swath control technology would be…	1	2	3	4	5
	…not be willing to use swath control technology for planters				**…be willing to** use swath control technology for planters
b. I would …	1	2	3	4	5
	Much Risk				**Not much Risk**
c. Using swath control technology for planters would expose me to…	1	2	3	4	5
	Strongly Disagree				**Strongly Agree**
d. I would be concerned about using swath control technology for planters	1	2	3	4	5
e. I think using swath control technology for planters would be risky	1	2	3	4	5
f. I would be willing to accept the risk of using swath control technology for planters	1	2	3	4	5

11. The following statements are about your general thoughts and feelings regarding technology. Please indicate for each statement to what extent you agree with it.

	Strongly Disagree				Strongly Agree
I prefer to use the most advanced technology available	1	2	3	4	5
There is no such thing as a manual for a high-tech product or service that is written in plain language	1	2	3	4	5
Technology makes me more efficient in my occupation	1	2	3	4	5
I can usually figure out new high-tech products and services without help from others	1	2	3	4	5
I do not consider it safe to do any kind of financial business online	1	2	3	4	5
I find I have fewer problems than other people in making new technology work for me	1	2	3	4	5
Technical support lines are not helpful because they don't explain things in terms I understand	1	2	3	4	5
I like computer programs that allow me to tailor things to fit my own needs	1	2	3	4	5
When I get technical support from a provider of a high-tech product or service, I sometimes feel as if I am being taken advantage of by someone who knows more than I do	1	2	3	4	5
I do not consider it safe giving out a credit card number over a computer	1	2	3	4	5
I enjoy the challenge of figuring out high-tech gadgets	1	2	3	4	5
I worry that information I send over the internet will be seen by other people	1	2	3	4	5

12. The following statements are about your thoughts about swath control technology for planters, relative to planters without this technology. Please indicate for each statement to what extent you agree with it or feel it applies to you by circling the appropriate response.

	Strongly Disagree				**Strongly Agree**
I have a lot of knowledge about swath control technology for planters	1	2	3	4	5
My colleagues will be very supportive of the use of swath control technology for planters for my job	1	2	3	4	5
I am very familiar with swath control technology for planters	1	2	3	4	5
I think that people who influence my behavior think that I should use swath control technology for planters	1	2	3	4	5
My colleagues will be helpful in the use of swath control technology for planters	1	2	3	4	5
We have the knowledge necessary to use swath control technology for planters	1	2	3	4	5
In general, my colleagues will support the use of swath control technology for planters	1	2	3	4	5
Farmers who own swath control technology for planters will have more prestige than those who do not	1	2	3	4	5
I do not have much experience using swath control technology for planters	1	2	3	4	5
Having swath control technology for planters will be a status symbol in my social environment	1	2	3	4	5
I have the resources necessary to use swath control technology for planters	1	2	3	4	5
Specialized instruction concerning swath control technology for planters will be available to me	1	2	3	4	5
In light of the resources, opportunities, and knowledge required to use swath control technology for planters, it would be easy for me to use swath control technology for planters	1	2	3	4	5
I think that people who are important to me think that I should use swath control technology for planters	1	2	3	4	5
Assistance will be available to deal with system difficulties	1	2	3	4	5
Farmers who own swath control technology for planters have a high profile	1	2	3	4	5

13. The following statements are about your feelings about swath control technology for planters, relative to planters without this technology. Please indicate for each statement to what extent you agree with it or feel it applies to you by circling the appropriate response.

	Strongly Disagree				**Strongly Agree**
I would think using swath control technology for planters is pleasant	1	2	3	4	5
It scares me to think I could get into problems when using swath control technology for planters	1	2	3	4	5
I would find working with swath control technology for planters to be fun	1	2	3	4	5
I would hesitate to use swath control technology for planters for fear of ending up with problems that cannot be corrected	1	2	3	4	5
I would like working with swath control technology for planters	1	2	3	4	5
Swath control technology for planters is somewhat intimidating to me	1	2	3	4	5

Please answer the following questions about your organization:

14. In which state of the country is your farm located? ________________

15. Please indicate which of the following geographic features apply to the location of your farm (check as many as applicable).

☐ **Mountains** ☐ **Trees** ☐ **River** ☐ **Hills** ☐ **Rocks**

16. What is the total size of your farm? ________________ **Acres**

17. How many employees are employed in your farm per year?

Full time ________________ employees **Part time** ________________ employees

18. What is the average age of the employees in your farm? ________________

19. Does your family work with you in your farm? ☐ **Yes** ☐ **No**

If **Yes**, is your family involved in farm equipment purchase decisions? ☐ **Yes** ☐ **No**

20a. What is the title/position of the person who would work most with swath control technology for planters? _____________________________

20b. How much influence does this person have on the purchase decision of swath control technology for planters?

Not much influence 1 2 3 4 5 **Much influence**

21a. How many people are involved in purchase decisions of farm equipment in your farm? ____________

21b. On average, approximately how many different sources of information do you use when making a decision on your farm operations?

Very few sources 1 2 3 4 5 **Many sources**

21c. On average, about how far in the future are plans made that affect your farming operation?

☐ < 1 month
☐ 1 - 2 months
☐ 3 - 6 months
☐ 7-12 months
☐ > 1 year

22. Please indicate which crops you plant and how many acres of these crops are planted.

Crops	**Acres**
1.	
2.	
3.	
4.	
5.	
6.	
7.	
Total acres	

23. Please respond to the following two statements regarding the shape (regular vs. irregular) and the number of obstacles (e.g., trees, ponds) associated with your fields.

	Very Irregular				**Very Regular**
The shape of many of my fields is …..	1	2	3	4	5

	Many Obstacles				**No Obstacles**
Many of my fields have …..	1	2	3	4	5

24. Please indicate for which crops you would use swath control technology for planters, and for which one you would never use the system.

I would use it for……	**I would NOT use it for……**
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.

25. How many rows does your Planters have? ___________ **rows**

26. Suppose the average price of a 16-row Planters is $80,000.

a. How much would you be willing to pay extra for a Planters with swath control technology that automatically controls <u>each half of 8 row units at the time</u>? $_____________ more

b. How much would you be willing to pay extra for a Planters with swath control technology that automatically controls <u>each individual row unit</u>? $_____________ more

27. Do you currently own/use

…… a GPS receiver system? ☐ **No** ☐ **Yes**

…… an Swath Control Technology for Planter? ☐ **No** ☐ **Yes**

…… swath control technology for sprayers? ☐ **No** ☐ **Yes**

…… a yield monitor? ☐ **No** ☐ **Yes**

…… grid soil sampling? ☐ **No** ☐ **Yes**

28a. Please indicate approximately what your annual budget for equipment is?

☐ Less than $25,000
☐ $25,000 - $49,999
☐ $50,000 - $99,999
☐ $100,000 - $199,999
☐ $200,000 - $299,999
☐ $300,000 - $399,999
☐ $400,000 - $499,999
☐ $500,000 or more

28b. Please indicate approximately what your annual gross farm revenue is?

☐ Less than $250,000
☐ $250,000 - $499,999
☐ $500,000 - $999,999
☐ $1,000,000 - $1,999,999
☐ $2,000,000 - $2,999,999
☐ $3,000,000 - $3,999,999
☐ $4,000,000 - $4,999,999
☐ $5,000,000 or more

29a. Have you expanded your operation, in acres, in the last 5 years?

☐ **No**

☐ **Yes, I expanded by __________ acres**

29b. Do you plan to grow your operation, in acres, in the next five years?

☐ **No**

☐ **Yes, I plan to grow by __________ acres**

Please answer the following questions about yourself:

30. How many years have you been working in the agriculture industry? ________ **years**

31. Please describe your educational history. Check as many as needed and please describe your major.

Level of education	Major
☐ No formal education	______________________
☐ Less than high school graduate	______________________
☐ High school graduate/GED	______________________
☐ Vocational training	______________________
☐ Some college/Associate's degree	______________________
☐ Bachelor's degree (BA, BS)	______________________
☐ Master's degree (or other post-graduate training)	______________________
☐ Doctoral degree (PhD, MD, EdD, DDS, JD, etc.)	______________________

32. What is your gender? ☐ **Female** ☐ **Male**

33. What is your age? ________ **years**

34. Do you belong to any local, regional, or national farm organization (mark as many as applicable)?

☐ **local farm organization**

☐ **regional farm organization**

☐ **national farm organization**

35. Please describe any factors that you will consider in deciding (not) to buy swath control technology for planters.

……………………………………………………………………………………………………

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Thank you for your participation!!